Remarks

Reconsideration and reexamination of this application, as amended, are respectfully requested. Claims 12-14 and 16-18 are pending in this application upon entry of this Amendment. In this Amendment, the Applicant has amended the title. Claims 12-14 and 16-18 remain unchanged upon entry of this Amendment.

The Drawings

In the final Office Action mailed on May 30, 2003, the Examiner approved of the proposed drawing correction filed by the Applicant on April 7, 2003. Accordingly, the Applicant has filed herewith corrected (formal) drawings in reply to the final Office Action.

Claim Rejections - 35 U.S.C. § 103

The Examiner rejected claims 12-14 and 16-18 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,018,778 issued to Stolowitz ("Stolowitz") in view of White, How Computers Work ("White"). The Applicant believes that the claimed invention is patentable over any combination of Stolowitz and White.

1. The Claimed Invention

The claimed invention, as recited in independent claims 12 and 16, is a method and an associated system for providing data blocks from a magnetic tape to a host. The method and system are for use in a "single magnetic tape RAIT" environment. Such a single magnetic tape RAIT environment includes a magnetic tape having data blocks and a parity block serially arranged on a single track of the magnetic tape with the parity block following the data blocks. The parity block is based on the data blocks as conventionally known.

The method includes reading the data blocks sequentially from the track of the magnetic tape and determining if the data block currently being read is good or bad based on the reading of the data block currently being read. The data block currently being read is provided to the host if the currently being read data block does not follow a bad data block. If one of the data blocks is bad, the method includes storing the good data blocks following the bad data block in sequential order.

Parity of the good data blocks is accumulated as the data blocks are being read. The parity block is then read from the track of the magnetic tape after all of the data blocks have been read. If one of the data blocks is bad, the bad data block is then reconstructed from the accumulated parity of the data blocks and the parity block in order to form a reconstructed good data block. The reconstructed good data block is then provided to the host and then the stored good data blocks are provided to the host in sequential order.

2. <u>Stolowitz and White</u>

The Examiner posited that Stolowitz discloses the claimed invention with the exception of explicitly disclosing a magnetic tape having data blocks and a parity block in which the data blocks and the parity block are serially arranged on the magnetic tape with the parity block following the data blocks and being based on the data blocks. The Examiner posited that White discloses the format of a tape having parallel tracks with each track being divided into segments of blocks of bytes. Specifically, each track being divided into 512 or 1,024 bytes and each segment typically containing 32 blocks. The Examiner posited that eight blocks in a segment contain error-correction codes and, as a result, the tracks comprise both data and parity.

3. <u>The Claimed Invention Compared to Stolowitz and White</u>

The claimed invention generally differs from any combination of Stolowitz and IBM in that the claimed invention is directed to an implementation of RAIT on a track of a

single magnetic tape. As such, the data blocks and the parity block are serially arranged on a track of the magnetic tape with the parity block following the data blocks. The data blocks are read sequentially from the track of the magnetic tape and then the parity block is read from the magnetic tape after all of the data blocks have been read.

As such, the claimed invention uses a parity block which is redundancy information calculated from the data blocks. The principle of the parity block is as follows: take "N" data blocks and from them compute the parity block so that there are now "N+1" blocks. If any one of the "N+1" blocks is unreadable, the unreadable block can be reconstructed from the remaining "N" blocks, regardless of which block is unreadable. The calculation for determining the parity block and reconstructing an unreadable block is typically the logical "exclusive OR" or "XOR" operation as recited in dependent claims 13-14 and 17-18.

In contrast, White teaches the use of an error-correction code (ECC) in some of the blocks of a segment in a track. An ECC is generally implemented by splitting data of data blocks at the bit level and then spread over a number of blocks (such as eight of the thirty-blocks in a segment as disclosed by White). As such, some of the blocks contain both data and the ECC. Typically, a Hamming code is used to calculate the ECC from the data bits.

Accordingly, White does not teach or suggest data blocks and a parity block serially arranged on a track of the magnetic tape with the parity block following the data blocks. In contrast, White teaches blocks serially arranged on a magnetic tape track with some of the blocks being data blocks and some of the blocks being data and ECC blocks. As such, if a block containing both data and the ECC were unreadable, then it is not clear as to how White would be able to construct the data in this unreadable block. In contrast, the claimed invention enables any unreadable block to be constructed from all of the remaining blocks. Therefore, modifying Stolowitz with White would not result in the claimed invention.

4. Reply to the Examiner's Response to Arguments

a. Single Tape RAIT

In paragraph 6 of the final Office Action, the Examiner requested an explanation of how a Redundant Array of Inexpensive/Independent Tapes (RAIT) is capable of being on a single tape. Initially, the Applicant directs the Examiner's attention to the website www.pcguide.com/ref/hdd/perf/raid/ which the Applicant referenced in preparing the Amendment filed on March 31, 2003. As indicated below, the Applicant has provided herewith copies of certain web pages from this website pursuant to the Examiner's request with regard to error-correction codes. The provided web page copies may also assist the Examiner in understanding the Applicant's phraseology concerning "single tape RAIT".

As indicated above, the method and system of the claimed invention are for use in a single tape RAIT environment. That is, the claimed invention is directed to an implementation of RAIT (or RAID) on a tape track. In RAIT (and RAID) a serial data stream is partitioned into data blocks and then written (striped) across multiple tape (or disk) drives. For example, the serial data stream is partitioned into n-1 data blocks and there are n tape drives. In order to write the data stream to the tape drives, data block #1 is striped to tape drive #1, data block #2 is striped to tape drive #2, and so on. After data block #n-1 is striped to tape drive #n-1, a parity block is striped to tape drive #n. The parity block is based on the n-1 data blocks. On the read operation, all of the tape drives are read such that the data blocks are read from the tape drives in a manner to form the serial data stream. For example, data block #1 is read from tape drive #1, data block #2 is then read from tape drive #2, and so on until the parity block is read from tape drive #n. If needed, the parity block is used with the other data blocks to reconstruct a bad data block in order to effectively make the data stream intact.

In single tape RAIT in accordance with the claimed invention, data blocks are written normally to a tape track except that a parity block is written after n data blocks (n being

equal to the number of tape drives in RAIT). Thus, if n = 4, the tape track will contain a first set of four serially arranged data blocks and then a first parity block based on the first set of data blocks, then a second set of four serially arranged data blocks and then a second parity block based on the second set of data blocks, and so on. Arranging a set of data blocks and a corresponding parity block on a single tape track in this manner makes sense because the common failure mode of a single tape is the loss of a block. In contrast, it would not make sense to write a set of data blocks and a corresponding parity block on a single disk track because the common failure mode of a disk is the loss of the disk itself.

In effect, the implementation of the single tape RAIT in accordance with the claimed invention is intended to convey the idea that a tape track has a serially arranged set of of data blocks with a corresponding parity block. This is analogous to the typical RAIT in which each data block of a serially arranged set of data blocks is striped to a respective tape drive with the corresponding parity block also being striped to a respective tape drive.

b. <u>ECC</u>

In paragraph 7 of the final Office Action, the Examiner requested that the Applicant provide a copy of the reference used by the Applicant in explaining the difference between parity and ECC in the context of the claimed invention. As indicated above, attached please find two sets of web pages taking from <u>www.pcguide.com/ref/hdd/perf/raid/</u>.

The first set of attached web pages, which fall under the attached web page entitled "General RAID concepts", include the following entitled web pages:

1. Physical and Logical Arrays of Drives;
2. Striping; and
3. Parity.

The second set of attached web pages include the following entitled web pages:

1. RAID Level 2; and
2. RAID Level 4.

The web page entitled "Striping" includes a block diagram showing a RAID striping configuration. This diagram illustrates how a stream of data is broken into blocks and then distributed to different disk drives. This web page notes that "RAID 3 and RAID 7 use byte-level striping with parity; and RAID 4, RAID 5 and RAID 6 use block-level striping with parity." This web page notes that RAID 2 provides "oddball bit-level striping with ECC defined by that RAID type."

The web page entitled "Parity" notes that parity is a data redundancy technique which provides data protection and is an alternative to mirroring. This web page notes that the term "parity" is used in the context of system memory error detection as well in the context of RAID (RAIT). This web page further indicates that the parity used in RAID is very similar in concept to parity RAM. The end of this web page further states that "RAID 2 uses a concept similar to parity but not exactly the same."

The web page entitled "RAID Level 2" recites:

> RAID 2 uses something *similar* to striping with parity, but not the same as what is used by RAID levels 3 to 7. It is implemented by splitting data at the *bit* level and spreading it over a number of data disks and a number of redundancy disks. The redundant bits are calculated using Hamming codes, a form of error correcting code (ECC).

The web page entitled "RAID Level 4" describes RAID 4 as being block-level striping with dedicated parity. This web page describes that in RAID 4 the set of data blocks are striped to respective data disks with the parity block (based on the data blocks) being striped to a dedicated parity disk. As such, the described RAID 4 is similar to the claimed single tape RAIT configuration in which "the data blocks and the parity block are serially arranged on a track of the magnetic tape with the parity block following the data blocks and the parity block being based on the data blocks" as set forth in the independent claims.

As such, the attached web pages distinguish between parity and ECC as used in the context of RAID (RAIT). Again, the claimed invention includes using a parity block which is based on the data blocks in a manner similar to RAID 4. In contrast, White teaches ECC in some of the blocks of a segment in a track in which the ECC is implemented by splitting data of data blocks at the bit level and then spread over a number of blocks (such as eight of the thirty-blocks in a segment as disclosed by White).

With respect to the interchangeable use of the words "ECC" and "parity" as set forth in U.S. Patent No. 3,755,779, the Applicant notes that this patent is directed to correcting errors in a code word or byte (i.e., errors in RAM). The code word is formed of a series of binary bit values. The ECC or parity check has a binary value of either 0 or 1 (assuming that this field is only one bit long) depending upon whether all of the bits of the code word taken individually add up to an even or odd value. For example, if the code word is "1 0 1" then the bits of this code word add to an even value (i.e., 1 + 0 + 1 = even value). The ECC or parity check would then be set to the value of "0". When the code word is read the ECC or parity check would also be read to ensure that the code word is read correctly. For instance, if the code word "1 0 1" was read incorrectly as "0 0 1" then the reader would know there is a problem because the ECC or parity check value of "0" would be inconsistent (i.e., 0 + 0 + 1 = odd value); but ECC or parity check value of "0" indicates that the value should be even.

In any event, the ECC provided by White is not the same as the parity described and claimed by the claimed invention. (See the web page entitled "Parity".)

In view of the foregoing remarks, the Applicant believes that independent claims 12 and 16 are patentable over Stolowitz and White. Claims 13-14 and 17-18 depend from one independent claims 12 and 16. Therefore, the Applicant requests reconsideration and withdrawal of the rejection to the claims under 35 U.S.C. § 103(a).

CONCLUSION

In summary, claims 12-14 and 16-18 meet the substantive requirements for patentability. The case is in appropriate condition for allowance. Accordingly, such action is respectfully requested.

If a telephone or video conference would expedite allowance or resolve any further questions, such a conference is invited at the convenience of the Examiner.

Respectfully submitted,

STEPHEN FULD

By____________________________
James N. Kallis
Reg. No. 41,102
Attorney for Applicant

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BROOKS & KUSHMAN P.C.
1000 Town Center, 22nd Floor
Southfield, MI 48075
Phone: 248-358-4400
Fax: 248-358-3351